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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of UNITED STATES DEPARTMENT OF ENERGY PROJECT MANAGEMENT CORPORATION TENNESSEE VALLEY AUTHORITY (Clinch River Breeder Reactor Plant)	)	Docket No. 50-537

NRC STAFF TESTIMONY OF HOMER LOWENBERG,
EDWARD F. BRANAGAN, JR., A. THOMAS CLARK, JR.,
AND REGIS R. BOYLE REGARDING CONTENTION 6

Q 1 Mr. Lowenberg, please state your name and present occupation

A 1 My name is Homer Lowenberg, Chief Engineer for the Office of Nuclear Material Safety and Safeguards.

Q 2 Please summarize your educational background and relevant work experience.

A 2 I am a graduate of Stevens Institute of Technology with degrees in mechanical and chemical engineering and am a professional engineer in the states of Pennsylvania and New York.

I have over 25 years experience in the commercial design, construction and operation fields related to a wide variety of nuclear facilities for both the government and industry.

Particularly relevant commercial experience includes major responsibilities with regard to the design and construction of a number of reprocessing and fuel fabrication facilities: for the U.S. government at Richland, Washington and Oak Ridge, Tennessee; for the Italian, Swedish and Indian governments; and for a division of the Atlantic Richfield Co.

For the past ten years I have been employed by the Atomic Energy Commission and the Nuclear Regulatory Commission of the U.S. Relevant government experience includes my assignments as assistant director and chief engineer in licensing of commercial nuclear fuel material activities. I was the program manager for NRC's generic analysis of mixed oxide fuel use in light water reactors (GESMO); a member of the U.S. delegation to the International Fuel Cycle Evaluation for the area of fuel reprocessing and recycle; and am involved in the TMI-2 Waste Management Task Force. Further details of my background are contained in my qualifications statement which is attached to this testimony.

Q.3: Please describe the scope of your participation in the Staff's Environmental review of the CRBRP.

A.3: I am the NMSS Project Manager responsible for the preparation of the Fuel Cycle portion of the Staff's supplement to the Final Environmental Statement for the CRBR Plant (FESS). I directed and participated in the review of the Applicants' updated Environmental Report related to the various steps in the CRBR fuel cycle includ ;: 1) fuel fabrication 2) reprocessing, 3) waste management, 4) transportation, and 5) safeguards. Under my direction the effluent source terms were generated for each of the fuel cycle steps and radiological exposures were estimated for conversion to health effects.

To provide technical assistance to the NRC technical Staff, two support contracts were established. One was with Battelle Pacific Northwest Laboratories (BPNL) and the second was with Oak Ridge National Laboratory (ORNL). Both of these contractors worked under my direction. BPNL supplied key technical assistance in reviewing, assessing, and preparing the fuel cycle portions of the environmental impact statement (EIS). ORNL established a CRBR model based upon reactor data and physics calculations. This model, called ORIGEN2, was used to project the radiological composition of material leaving the reactor as spent fuel and also that of waste and product materials from the reprocessing operation.

The overall technical Staff that I directed was specifically responsible for the updating of Appendix D, "Environmental Effects of the CRBR Fuel Cycle and Transportation of Radioactive Materials;" Appendix E, "Safeguards Related to the CRBR Fuel Cycle and Transportation of Radioactive Materials;" section 7.2, "Transportation Accidents Involving Radioactive Material;" section 7.3, "Safeguards Considerations;" well as section 5.7.2.6, "Transportation of Radioactive Materials;" and section 5.7.2.7, "Fuel Cycle Impacts" of the EIS.

Q.4: Please state your name and affiliation.

A.4: My name is Edward Branagan. I am a Radiological Physicist with the Radiological Assessment Branch in the Office of Nuclear Reactor Regulation. My duties include evaluating the environmental radiological impacts from nuclear power reactors and, in particular, the health effects models for use in reactor licensing. A copy of my professional qualifications was received into evidence in this proceeding and appears at Tr. 2527.

Q.5: In regard to Contention6, what is the nature of the responsibilities you have regarding the Clinch River Breeder Reactor Fuel Cycle?

A.5: I was responsible for estimating dose commitments (hereinafter referred to as "doses") from exposures to radioactive effluents from routine operations of the core fuel fabrication facility and the fuel reprocessing plant (i.e., Section D.2.4.2 and D.2.4.3 of the Supplement). In Addition, I was responsible for part of Section D.2.4.6, "Summary of Radiological Impacts," Section 5.7.2.8, "Summary of Population Annual Doses," and Section5.7.3, "Evaluation of Radiological Impact to the General Public. I prepared responses to questions 21-24 of this testimony.

Q.6: Dr. Clark, please state your name and present occupation.

A.6: My name is Arthur Thomas Clark, Jr. I am a Senior Chemical Engineer in the Office of Nuclear Material Safety and Safeguards.

Q.7: Please summarize your educational background and relevant work experience.

A.7: I am a graduate of Rose-Hulman Institute of Technology with a Bachelor of Science degree in Chemical Engineering. I obtained a Doctor of Philosophy degree in Nuclear Engineering from the University of Maryland.

I worked for the DuPont Company at the Savannah River Laboratory and Plant on the development and testing of new equipment and processes for nuclear fuel processing. I have worked for the Federal Government for the last several years as a licensing project manager for fuel reprocessing and mixed oxide manufacturing plants.

Q.8: Please describe the scope of your participation in the Staff's environmental review of the CRBR environmental report.

A.8: I reviewed the information supplied by the Applicants concerning the reprocessing and fabrication of fuel from and for the Clinch River Breeder Reactor. I participated in meetings and discussions concerning this review and the Staff's preparation of the supplemental information to the Environmental Impact Statement. I coordinated the preparation of draft material on these subjects submitted by our consultant, Battelle Pacific Northwest Laboratories. I occasionally performed calculations related to estimating radiological impacts from fuel cycle operations related to the CRBR.

Q.9: Mr Boyle, please state your name and present occupation.

A.9: My name is Regis Boyle, Section Leader for the Projects Section, High-Level Waste Licensing Management Branch, Division of Waste Management.

Q.10: Please summarize your educational background and relevant work experience.

A.10: I received a Bachelor of Science degree in Engineering Mechanics from the Pennsylvania State University and a Master of Science degree in Mechanical Engineering from the University of Pittsburgh. I had completed some of the requirements toward a Doctor of Science degree in Mechanical Engineering at George Washington University. In addition, I have attended continuing education courses in the field of energy and nuclear engineering at MIT and Georgia Tech.

From April 1967 to November 1972, I was employed by Westinghouse Electric Corporation. Initially, I was a Staff Assistant in the Engineering Training Department and later a Generation Engineer in the Fuels and Energy Systems Department of the Power Systems Planning Group. As a Staff Assistant, I was responsible for assisting in the development of engineering training programs for technical employees. As a Generation Engineer, my major responsibilities were to perform long-range engineering, commercial and economic studies and evaluation on both state-of-the-art and advanced power systems such as nuclear power, coal gasification, and closed-cycle cooling systems.

In December 1972, I joined the U.S. Nuclear Regulatory Commission as a Cost-Benefit Specialist in the Cost-Benefit Analysis Branch. In this position, I was responsible for reviewing Applicants' environmental reports and preparing the need for power, alternative energy sources, alternative sites and plant designs, and the cost-benefit analysis sections of the Staff's environmental statements. The environmental statements in which I prepared sections were Bellefonte, Fulton, and North Coast. In addition, I prepared portions of the cost-benefit analysis section of the Staff's Final Environmental Statement on Emergency Core Cooling Systems.

In June 1975, I was appointed to the position of Environmental Project Manager. In this capacity I was responsible for the environmental review of the Phipps Bend Nuclear Plant, Jamesport Nuclear Station, Bellefonte Nuclear Plant and the Washington Public Power Supply System No. 2 Plant.

In January 1978, I was assigned to the Division of Waste Management. As a Section Leader of the Project Section, I am responsible for supervising a group of engineers and scientists who evaluate and analyze the waste management aspects of technical projects such as the West Valley Demonstration Project, the Defense Waste Processing Facility, the Waste Confidence proceeding and the CRBRP. I am a member of the American Society of Mechanical Engineers and a registered Professional Engineer in the State of Pennsylvania.

Q.11: Please describe the scope of your participation in the Staff's review of the CRBR.

A.11: I participated in the preparation of those sections of Appendix D of the supplement to the FES that deal with the waste management aspects of the CRBR nuclear fuel cycle.

Q.12: What issues does this testimony address?

A.12: This testimony addresses Contention 6(b)(1), 6(b)(3) and 6(b)(4) as stated below:

b) The impacts of the actual fuel cycle associated with CRBR will differ from the model LMFBR and fuel cycle analyzed in the LMFBR Program Environmental Statement and Supplement. The analysis of fuel cycle impacts must be done for the particular circumstances applicable to the CRBR. The analyses of fuel cycle impacts in the ER and FES are inadequate since:

(1) The impact of reprocessing of spent fuel and plutonium separation required for the CRBR is not included, or is inadequately assessed;

(3) The impact of disposal of wastes from the CRBR spent fuel is not included, or is inadequately assessed;

(4) The impact of an act of sabotage, terrorism or theft directed against the plutonium in the CRBR fuel cycle, including the plant, is not included or is inadequately assessed, nor is the impact of various measures intended to be used to prevent sabotage, theft or diversion.

Q.13: In previous environmental reviews of the CRBR fuel cycle, the Staff considered a generic large scale commercial fuel cycle for a large scale LMFBR industry. How does the present Staff analysis of the CRBR fuel cycle including waste management and transportation of radioactive materials differ from previous efforts?

A.13: The Applicants originally submitted an Environmental Report (1975-76) when there was a strong likelihood that back-end commercial fuel cycle facilities and services would be available on a licensed commercial basis. Therefore, the NRC Staff was able to project how such operations might have been modified and used for CRBR application. Accordingly, the Applicants' and to some extent, the Staff's approach was based upon the assumption that the generic LMFBR environmental statement WASH-1535 was adequate as a basis to prorate the CRBR fuel cycle environmental effects from a larger commercial industry.

However, it now appears that the facilities and services previously contemplated will most likely not be licensed for commercial operation in the near future. The Staff has requested and obtained from the Applicants an updated fuel cycle approach that projects facilities that are planned to be utilized for CRBR fuel cycle work. This information has been provided through supplements to the CRBR Environmental Report. Amendment XIV, which is the basis for the FESS, describes the Applicants' plans for carrying out the fuel cycle activities, including transportation, waste management and safeguards, and the assessment of the environmental impacts resulting from these CRBR fuel cycle operations.

The Staff reviewed the Applicants' submittals in sufficient depth to independently determine the environmental effects and to draw conclusions as to: a) the reasonableness of the approach, b) the credibility and conservativeness of the assessment methods used by the Applicants, and c) the use of the best available information and analysis techniques.

The basis of the Staff environmental analysis in the FESS was the fuel cycle reported in the supplemental information provided by the applicants, (Amendment XIV), which projects a mix of facility scenarios. Some facilities are firmly planned and their sites selected; others are conceptual and their sites are yet to be selected. For the firmly planned facilities (e.g., mixed oxide fuel fabrication and fuel assembly), the Staff has depended to a large extent on information provided in existing DOE environmental assessment documents. This assessment methodology was not possible for the facilities that are less well established which include: the commercial blanket fuel fabrication plant; the reprocessing plant; the sites anf facilities for low-level, TRU and high-level waste storage and disposal. For such operations, no DOE specific site or facility assessment exists. Therefore, considerations for Staff evaluations have been based upon a combination of generic or model facility concepts and site conditions, and related commercial or government experience with the use of appropriate scaling factors.

In summary, for the latest Staff assessment of CRBR fuel cycle effects, the Staff has obtained from DOE its current projection of actual unit operations to be carried out for such needs. In this case the Staff evaluation has been based upon a variety of techniques including:

- DOE assessments
- commercial or government experience, and
- generic or model operations

Q.14: Why does the Staff believe that the approach used is appropriate for this project?

A.14: The Staff reviewed the projected DOE plans for individual fuel cycle facilities and services on a step by step basis and performed its independent assessment as summarized below. The source of depleted UF_6 for the blanket fuel assemblies would be existing tails stockpiles at DOE's Gaseous Diffusion Plants that have been generated from other programs; therefore, any effects from such operations are not attributable to the CRBR fuel cycle. The blanket fuel assemblies and depleted uranium dioxide fuel materials for the core fuel assemblies would be manufactured at some existing commercial fuel fabrication plant. Information from generic analyses of uranium fuel fabrication plant environmental effects and data from existing plants was used to develop environmental effects from this operation for the CRBR fuel cycle. The fabrication of the uranium dioxide and plutonium dioxide portions of the core assemblies would be handled by operations at the Secure Automated Fabrication (SAF) line in the Fuels Manufacture and Examination Facility (FMEF) and assembly would

be performed at the Fuels Development Laboratory (Building 308) on the Hanford Reservation. Since the latter facility exists and the former plant is under construction the Staff assessment of these operations was primarily based upon published DOE data for these facilities at that site.

The completed assemblies would be shipped in special transport vehicles to CRBRP for use. Following irradiation and a minimum of 100 days of cooling, the spent fuel would be transported in a heavily shielded cask to a reprocessing plant where the plutonium and uranium would be separated from each other and from the fission products and other transmuted actinides. The Applicants indicate that reprocessing may be carried out in any of several alternative ways. The Applicants state that the alternative that bounds the environmental effects for this operation is the projected Developmental Reprocessing Plant (DRP). The Staff based its assessment of the reprocessing step on the DRP proposed by DOE. The Staff believes that the environmental effects from this facility provide an upperbound for the environmental effects from any of several alternatives which might be chosen by DOE.

The radioactive wastes projected to be produced at the CRBRP and each of the fuel cycle steps were evaluated for their individual waste management requirements and effects. The low-level wastes (LLW) produced at the UF_6 and UO_2 conversion and fuel fabrication plant would be disposed of onsite or at commercial burial grounds. Transuranic (TRU) wastes would be placed into temporary retrievable storage prior to eventual disposal in a Federal

geologic repository. High-level waste (HLW) after solidification at the reprocessing plant would be stored temporarily until final disposal in a Federal geologic repository. Other LLW from reprocessing and the CRBRP would be disposed of in a licensed, commercial shallow-land burial ground. The Staff analysis of these waste management activities is based upon generic considerations of such operations, since these CRBR wastes are similar to other radioactive wastes, and specific sites are not available for evaluation. The Staff assessment of environmental effects from waste management is based upon comparison with management of other similar wastes.

The transport steps would involve operations that have been used for similar activities by industry or DOE. The Staff assessments of these operations is based upon generic studies of similar nuclear transportation activities.

Thus the Staff has considered the proposed CRBR fuel cycle steps and has independently assessed the resultant radiological effects based upon appropriate realistic or bounding conditions, analyses or operating data.

Q.15: Do the Staff conclusions from the present evaluation differ significantly from its previous findings?

A.15: A comparison of Staff findings from the latest evaluations with previous assessments can most easily be summarized by inspection of the projected radiological impacts. The radiological impacts of the CRBR fuel cycle operations were evaluated and presented in Appendix D of the FESS update and are summarized in Table D.17. Based upon the Staff assessment, the annual U.S. population whole-body dose from normal operations of the CRBR fuel cycle is projected to be approximately 170 man-rem which is less than 0.001% of the corresponding population dose from one year of exposure to natural background radiation. The previous Staff assessment of similar radiological effects is summarized in Table 5.13 of the FES, which projected annual whole body dose to the U.S. population of 34 man-rem. The latest projection of annual radiological whole body dose to the U.S. population is somewhat higher than the previous assessment due primarily to assumptions of higher levels of gaseous radiological releases from the DRP than from the projected large scale commercial plant. However, both assessment findings are very small fractions of the comparable U.S. population doses projected from natural background radiation (28,000,000 man-rem) and are small compared to the normal range of variations for such values. Accordingly, the Staff believes that its present findings, with regard to radiological dose from the CRBR fuel cycle are essentially of the same order of magnitude as its previous findings in the 1977 FES and are an insignificant factor in any cost/benefit balance for this project.

Since a number of the facilities are yet to be firmly established, the socioeconomic impacts from the CRBR fuel cycle have been considered qualitatively.

This assessment indicates that most such effects appear to be small (e.g., equivalent to those of any large capital project). For those portions of the CRBR fuel cycle that are similar to the commercial LWR nuclear reactor fuel cycle, the incremental effect of the CRBR fuel cycle portion is very small (approximately 1%) and is not considered to be a measurable or a significant increment. In summary, the Staff finds that the socioeconomic impacts from the CRBR fuel cycle are not a significant factor in the CRBR cost/benefit balance.

Q.16a: How did the Staff perform its review and assessment of spent fuel reprocessing where both the specific facility and the site are yet to be chosen?

A.16a: The Staff reviewed the updated information on spent fuel reprocessing provided by DOE in its Environmental Report on the Clinch River Breeder Reactor Project (CRBRP) (Amendment XIV), including material referenced therein. This material included DOE's present preference for carrying out this operation for the CRBR fuel cycle at the projected Developmental Reprocessing Plant (CRP) but included three other alternatives for this work. The Staff independently evaluated the likely environmental impact of the DRP, as broadly proposed by DOE drawing upon previous analyses of licensed reprocessing facilities, other extant information on government facilities, NRC projections of radionuclide inventories and plant separation factors. It determined that the radiological impacts consequent to operation of the DRP on CRBRP fuel, as projected by the Staff, are sufficiently conservative to envelop the likely environmental impact of any choice the DOE may make for reprocessing CRBRP fuel. Thus, the Staff assessment is conservatively based upon a bounding (high side) case for this operation.

Q.16b: How did the Staff perform its review and assessment of management and disposal of wastes where neither the specific facilities nor sites that will be used for handling, storage and disposal of low level (LLW), transuranic (TRU), or high level (HLW) wastes have been selected?

A.16b: The Staff reviewed the updated information on waste management provided by DOE in its Environmental Report on the CRBRP (Amendment XIV). This information identified each facility of the CRBR fuel cycle that would produce radioactive wastes. These facilities were identified to be (1) the blanket fuel fabrication plant, (2) the core fuel fabrication plant, (3) the reactor plant, and (4) the fuel reprocessing plant. For each of these facilities, the Staff independently assessed the quantity and types of radioactive waste that are likely to be generated over the life of the CRBR. These radioactive wastes were broadly categorized as low-level, high-level, and TRU wastes. In addition, small amounts of gaseous wastes, Kr-85 and I-129, will also be generated over the life of the CRBR.

The Staff projected that low-level waste would be disposed of in a suitable commercial shallow-land burial ground. The TRU waste was projected to be stored for a period of time and then transferred to a Federal repository. The high-level waste after solidification and packaging was projected to be transported to a Federal repository for disposal. The gaseous wastes, Kr-85 and I-129, were projected to be converted to solid forms and to be disposed of at a Federal repository.

The Staff compared these wastes with other similar wastes with regard to radionuclides of concern and then estimated the portion of a model or generic waste disposal facility that would be required for the disposition of the wastes from the CRBR. The Staff calculated the environmental impacts from the disposal of CRBR wastes as a fraction of all the environmental impacts that would result from the overall use of the disposal facility. The Staff found that the CRBR wastes were generally similar to other wastes that might result from the commercial nuclear power industry and that the portion of the waste management facilities that might be required for CRBR would be a small fraction of the total waste management needs (<1%).

Q.16c: How did the Staff review and assess the adequacy of safeguards measures on conceptual facilities and operations?

A.16c: The Staff's safeguards assessment was on a systems level, as deemed appropriate for an environmental impact review. The Staff did not attempt to evaluate operating procedures, equipment specifications, or other details of DOE's proposed CRBR safeguards systems. As is explained in the Staff testimony in response to Contention 4, the details of safeguards systems are not required until the operating license stage. The DOE's proposals were assessed in terms of their coverage of all necessary fuel cycle activities, their appropriateness to the types of activities to which they would be applied, and the likelihood that they would be able to protect against theft, diversion, and sabotage. The Staff was able to perform this systems level review with the general descriptions provided by the DOE in Amendment XIV to the CRBR Environmental Report. A summary of the Staff review is contained in Appendix E of the Staff's FESS.

Q.17a: Why does the Staff believe that its review and assessment of the future planned spent fuel reprocessing activities is an adequate evaluation.

A.17a: The operations for reprocessing of CRBR spent fuel planned by the applicant will use a variation of the well established Purex process. In addition the Staff's independent analysis of the radionuclide contents of the spent fuel indicates that it is not significantly different from commercial light water reactor spent fuel. Much has been learned about spent fuel reprocessing as a result of decades of experience in government operations and more limited commercial activities.

Utilizing all of these factors, the Staff independent evaluation of this activity for CRBR has been based upon conservative (low side) assessments of the capabilities of the projected DRP to contain and retain the radionuclide effluents. This bounding assessment methodology assumes that the reprocessing activity for CRBR accounts for about 80% of the radiological dose to the population from the entire CRBR fuel cycle. However, despite this conservative approach, the Staff finds that the radiological whole body exposure of the public from the entire CRBR fuel cycle is very small (<0.001%) compared with naturally occurring radioactivity.

This assessment is projected to bound the possible alternatives for this activity and still results in small, essentially immeasurable, contributions to whole body population exposures. Thus the Staff believes that its assessment of this projected CRBR activity is adequately characterized and the operations can be safely carried out within the bounds of this analysis.

Q.17b: Why does the Staff believe that its review and assessment of the future planned management and disposal of waste activities is an adequate evaluation?

A.17b: The Applicants have analyzed the projected wastes from each step in the CRBR fuel cycle and the means for their handling, storage and disposal. The Staff has reviewed this material and has performed an independent assessment of the effects of waste management. The Staff finds that the wastes are quite similar to radioactive wastes already being handled or planned to be handled by the nuclear industry or government. Further the Staff believes that the wastes from the CRBR fuel cycle will constitute a small contribution to wastes that must be handled regardless of the existence of the CRBR project.

The Staff review and assessment of the environmental effects from the management of CRBR fuel cycle wastes has been based upon extensive generic studies that estimated environmental effects of similar activities. These studies have been a part of NEPA activities related to other activities and are believed to be soundly based and appropriate for extrapolation to CRBR waste management activities.

Thus the Staff believes that its assessment of CRBR fuel cycle waste management activities adequately characterizes the potential environmental impacts of these future planned activities.

Q.17c: Why does the Staff believe that its review and assessment of the future planned Safeguards measures on conceptual facilities and operations is an adequate evaluation?

A.17c: The answer to this question is covered by the answer in A.16.c.

Q.18: Has the Staff considered any alternatives to the simplified fuel cycle presented by the Applicants in the Environmental Report Amendment XIV?

A.18: Yes. The fuel cycle presented by DOE in Section 5.7 of Amendment XIV to the ER represents in the Staff's view a simplified cycle for CRBRP fuel handling. The Staff has qualitatively considered what it believes to be a somewhat more realistic overall fuel cycle. It employs a once-through or opened fuel cycle during the early years of the CRBRP operations, followed by a closed fuel cycle utilizing repeated recycle of plutonium materials during later CRBRP operations.

Q.19: How did the Staff analyze this variation in the CRBR fuel cycle?

A.19: The Staff performed a qualitative sensitivity analysis of the more realistic CRBR fuel cycle.

Q.20: What effects on the analysis continaed in the draft supplement to the FES resulted from the sensitivity analysis?

A.20: In this sensitivity analysis the Staff has qualitatively considered reasonably expected variations to the simplified fuel cycle presented by DOE in the ER and believes that the reasonably expected modes of fuel cycle operations are bounded by the Staff's conservative environmental assessment, which is summarized in Section D.2.4.6. Further, no significant perturbations to the overall assessment of staff conclusions would be anticipated from reasonably expected variations to the simplified fuel cycle presented by DOE.

Q.21: Has the Staff calculated the quantities of radioactive materials to be released from routine operation of the core fuel fabrication facility and the fuel reprocessing plant?

A.21: Yes. The NMSS Staff estimated the quantities of radioactive effluents from these facilities. The quantities released per annual fuel requirement for CRBRP are listed in Table D.4 of the Supplement. The Staff used the values in Table D.4 of the Supplement to estimate the dose commitment to the U.S. population from exposure to radioactive effluent releases from the core fuel fabrication facility and the fuel reprocessing plant.

Q.22: Describe the environmental transport and dose models used by the Staff in estimating the doses from the core fuel fabrication and the reprocessing plant.

A.22: In estimating the doses in the Supplement, the Staff used mathematical models that characterize radionuclide movement in the environment. The computational code used for these estimates is the RABGAD code originally developed for use in the "Generic Environmental Impact Statement on the Use of Mixed Oxide Fuel in Light-Water-Cooled Nuclear Power Plants," i.e., GESMO.[1/] The following environmental pathways were considered in estimating doses: (1) inhalation and submersion in the plume during its initial passage; (2) ingestion of food; (3) external exposure from radionuclides deposited on soil; and (4) atmospheric resuspension of radionuclides deposited on soil. The dose conversion factors used in the RABGAD code are based primarily on ICRP Publication 2

1/ U.S. Nuclear Regulatory Commission (NRC). 1976a. Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors. NUREG-0002, Washington, D.C.

as updated by ICRP Publications 6 and 10.[2/] The environmental transport and dose models are described more fully in Chapter IV, Section J, Appendix A, "Dose Calculation Methodlogy," of Volume 3 of GESMO.[3/]

Q.23: What is the Staff's estimate of the dose to the population resulting from exposure to radioactive effluents from the core fuel fabrication facility and the fuel reprocessing plant?

A.23: The dose to the total body and critical organs of the U.S. population from exposure to radioactive effluents from the core fuel fabrication plant are estimated to be less than 0.1 person-rem. The dose to the total body of the U.S. population from exposure to radioactive effluents from the fuel reprocessing plant is estimated to be about 140 person-rems. Since over 99% of the estimated to the total body of the U.S. population is due to exposure to tritium and carbon-14, other radionuclides are relatively unimportant to this analysis. For perspective, the annual dose to the total body of the U.S. population from exposure to background radiation is about 28,000,000 person-rems.[4/] The population dose to the total body of the U.S.

2/ International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," Committee II, ICRP Publication 2, Oxford: Pergamon Press, 1959.

International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 6, Oxford: Perfamon Press, 1962.

International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 10, Oxford: Pergamon Press, 1968.

3/ Supra. footnote 1.

4/ Based upon a U.S. population of 280,000 persons (projected population for the year 2010) receiving a background dose of about 0.1 rem/yr.

population from exposure to radioactive effluents from these facilities is a very msall fraction (less than 0.001%) of the population dose from one year of exposure to natural background radiation.

Q.24: What do you conclude with respect to the issue in Contention 6(b)(1).

A.24: I conclude that the Staff adequately estimated the radiological impacts from exposure to radioactive effluents from the core fuel fabrication facility and the fuel reprocessing plant. In Table D.17 of the Supplement, the Staff presented estimates of the dose to the U.S. population from exposure to radioactive effluents from the fuel cycle. The estimated doses are a very small fraction (less than 0.001% of the population dose from one year of exposure of natural background radiation.

Educational and Professional Qualifications

Homer Lowenberg
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

My name is Homer Lowenberg. I am the Chief Engineer of the Office of Nuclear Material Safety and Safeguards. I am responsible for refinements of the technological base for improving and updating the licensing process and for the performance of generic and special studies in support of national and international policies and developments in the non-reactor areas of NRC's responsibilities. I am currently responsible for NRC's environmental review of the CRBR fuel cycle. In addition, I handle activities related to the fuel cycle aspects of the GESMO proceeding and LMFBR research; also, I participate in waste management aspects of the TMI-2 clean-up and in technical review of high and low level waste management programs.

I received the degree of Mechanical Engineer from Stevens Institute of Technology with distinction in Chemical Engineering and attended the Executive Development Program of Cornell University Graduate School of Business and Public Administration.

My professional career was initiated with 5 years of plant development and start-up activities for the Hercules Powder Company in smokeless powder, rocket propellants and high explosive operations.

Then I spent 20 years in the architect-engineering field with the Kellex Corporation which subsequently became Vitro Engineering Co. I was project manager for numerous nuclear facilities including AEC's Purex, Redox and Waste Metal Recovery reprocessing plants at Richland, Washington; the Italian and Swedish Reprocessing facilities; Consolidated Edison's Indian Point Nuclear Power Plant; the Indian Plutonium Laboratory; and a wide variety of nuclear and nonnuclear projects. When Vitro Engineering was sold to Ralph Parsons Co., I was manager of its New York operations.

I was Manager of Central Engineering for Atlantic Richfield Co.'s commercial nuclear activities for 5 years including planning, design and construction of all facilities for fuel material production, fuel assembly and manufacturing, fuel reprocessing and related functions.

I joined the Atomic Energy Commission in 1971 as an assistant director in the regulatory fuels and materials licensing area and continued with NRC upon its creation in 1974. As an assistant director I was responsible for initiating the Reactor-Fuel Cycle Rule (now 10 CFR 51, Tables S-3 and S-4).

I was the program manager and chief commission witness for the GESMO proceeding on widescale mixed oxide use in LWRS; a member of the U.S. delegation to the International Fuel Cycle Evaluation Working Group 4 on Pu reprocessing and recycle and on the TMI-2 Waste Management Task Force.

I am a professional engineer in the states of New York and Pennsylvania.

I was one of the editors of the Reactor Handbook, Volume II published by the AEC on Fuel Reprocessing and have been the program leader on numerous AEC and NRC projects that have been the subject of agency reports.

EDUCATIONAL AND PROFESSIONAL QUALIFICATIONS

Arthur Thomas Clark, Jr.
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission

My name is A. Thomas Clark, Jr. As a Senior Chemical Engineer I am responsible for managing the safety review of nuclear fuel cycle facilities.

I graduated from Rose Polytechnic Institute (now Rose-Hulman Institute of Technology) in Terre Haute, Indiana in 1958 with a Bachelor of Science Degree in Chemical Engineering. In 1972 I graduated from the University of Maryland in College Park, Maryland with a Doctor of Philosophy Degree in Nuclear Engineering. At the University I was a licensed reactor operator.

From 1958 to 1964 I was employed by the E. I. DuPont De Nemours Company at the Savannah River Laboratory and Plant. I participated in process developmental activities associated with the chemical separations facilities including ion exchange, solvent extraction, dissolution, feed clarification and other aspects of such operations. I provided technical support for the Receiving Basin for Off-Site Fuel and participated in technical studies related to plant improvements and new processes.

In 1964 I joined the Atomic Energy Commission's Regulatory staff as a Chemical Engineer, participating in the safety review of separation facilities. I left the Commission in 1965 to attend graduate school, returning in 1971.

Since 1971 I have been the Project Manager for the safety review and evaluation of the Midwest Fuel Recovery Plant (later the Morris Operation Spent

Fuel Storage Facility) and the Recycle Fuels Plant. I have been responsible since 1973 for the Commission's program for the testing and licensing of operators for reprocessing facilities under 10 CFR Part 55. I participated in the preparation of the Draft Generic Environmental Statement for the wide-scale use of Mixed Oxide fuel (GESMO), in particular accident analysis and reprocessing and plutonium storage sections.

I also have been asked to serve on several task forces for 1) the review of material control and accountability plans, 2) the study of the possibility of licensing DOE waste management activities, and 3) the review of the DOE's Generic Environmental Statement for the Long-Term Management of High-Level Waste. I currently serve on four research review groups for the Commission's Office of Regulatory Research.

I have been a member of the American Nuclear Society and the American Institute of Chemical Engineers.

EDUCATIONAL AND PROFESSIONAL QUALIFICATIONS

Regis R. Boyle
Division of Waste Management
U. S. Nuclear Regulatory Commission

My name is Regis R. Boyle. I am the Section Leader of the Projects Section, High-Level Waste Licensing Management Branch, Division of Waste Management. As Section Leader of the Projects Section, I am responsible for the management, coordination, and planning of the high-level waste management aspects of NRC rulemaking and project specific activities. I am currently responsible for the proposed rulemaking on the storage and disposal of nuclear waste (waste confidence proceeding) and the technical review of the waste management aspects of the West Valley Demonstration Project.

I received a Bachelor of Science in Engineering Mechanics from the Pennsylvania State University and a Master of Science in Mechanical Engineering from the University of Pittsburgh. I have completed additional graduate studies at George Washington University in Mechanical Engineering.

From 1975 to 1978, I was a project manager with the Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation. In this position, I managed the preparation of environmental impact statements on the Jamesport Nuclear Station and the Phipps Bend Nuclear Plant.

From 1972 to 1975, I was with the Division of Technical Review in the Directorate of Licensing, U. S. Nuclear Regulatory Commission. In this position, I performed cost-benefit analyses on nuclear power plants. I was responsible for the evaluation of energy alternatives and prepared

portions of environmental impact statements for about six nuclear power plants.

Prior to joining the NRC (formerly the U. S. Atomic Energy Commission), I was employed by Westinghouse Electric Corporation. As a Power Generation Engineer, I performed feasibility studies on various methods of electric power generation including nuclear, fossil, and hydroelectric power production.

I am a member of the American Society of Mechanical Engineers and a registered professional engineer in the state of Pennsylvania.